REPORT

OF THE THIRD CIMMYT -CIO

COLLABORATIVE PLANNING

MEETING

CIRAD, Montpellier (France)

30-31 May 1994

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Participants	Institution
CIMMYT	
Roger ROWE	CIMMYT/Deputy Director General Research. Mexico
George VARUGHESE	CIMMYT/Associate Director Wheat Program. Mexico
Delbert HESS	CIMMYT/Maize Program Director. Mexico
David HOISINGTON	CIMMYT/Head Applied Biotechnology Laboratories. Mexico.
Edmundo ACEVEDO	CIMMYT/Wheat Program Leader Crop Management and Physiology
CIQ	
François VICARIOT	CIRAD/Paris Director External Relations
Michel EDDI	CIRAD/Paris Deputy Scientific Director
Jacques LEFORT	CIRAD - Annual Crops Department/Director
Harry PALMIER	CIRAD - Annual Crops Department/International Relations
Jean-Claude FOLLIN	CIRAD - Annual Crops Department/Scientific Director
Patrick BISSON	CIRAD - Annual Crops Department/Cropping System Research Unit
Michel CRETENET	CIRAD - Annual Crops Department/Cropping System Research Unit
Jean-Leu MARCHAND	CIRAD - Annual Crops Department/Maize andSorghum Research Coordination
Eric SCOPEL	CIRAD - Annual Crops Department/ Agronomist based in Mexico
André CHARRIER	ENSAM/Plant Breeding

Antoine CORNET	ORSTOM/Department of Environment and Agriculture Director
Guy HAINNAUX	ORSTOM/Department of Environment and Agriculture Deputy Director
Philippe BOURRET	ORSTOM/Delegate International Relations
Andrée SONTOT	INRA/International Relations Direction
Brigitte GOUESNARD	INRA/Scientific researcher - maize genetic resources program - Genetic and plant breeding
Dominique THIS	INRA/ENSA Genetic & plant improvement
François KAHN	INRA/research Director, Genetic and plant improvement
Gérard DOUSSINAULT	INRA/Genetic and Plant Breeding Department
Julien BERTHAUD	ORSTOM-CIMMYT/Plant breeding. Mexico

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SUMMMARY OF DISCUSSIONS AND DECISIONS

I - CONTEXT.

François Vicariot, Director for External relations of CIRAD welcomed the CIMMYT delegation.

CIO and CIMMYT have now a solid understanding of their scientific objectives, comparative advantages and modes of operation.

The second Collaborative Planning meeting in El Bàtan, in february 1992, marked a cornerstone in this CIO/CIMMYT collaboration by establishing three different types of Programs to facilitate preliminary discussions among scientists and the management of the two Institutions for the elaboration and implementation of collaborative projects.

The French Research Institutions are operating under operational constraints similar to that of the CGIAR Centers like CIMMYT.

CIO wishes to bring its contribution to the production of more adapted, environmentally-safe and sustainable technologies for agricultural development and is convinced that collaborative research activities with partners like CGIAR Centers are a valuable asset for reaching the "critical masses" of scientists, that can make possible breakthroughs in basic, applied and adaptative research.

Roger Rowe stressed CIMMYT desire to increase its collaboration with the French Institutions.
CIMMYT is facing today a drastic reduction of funding and staff. Therefore it has to examine all projects very carefully, including those in partnership with CIO.

An important orientation is the creation of a Natural Resources Management Research Group(NRMR) which cuts across Programs (Maïze, Wheat, Economics), building on CIMMYT past
work, linking crop improvement to maintain productivity and the preservation of environment. The NRMR principal projects are presently :

- . Combating erosion in hillsides maize-based systems in Mexico and Central America
- . Management of low fertility soils in maïze-based systems in East and Southern Africa
- . Resource management issues in rice-wheat systems in South Asia

Dr. Delbert Hess briefly reviewed the activities of the Maïze Program and noted that the CIMMYT maïze Program is increasing its activities funded through special Projects.

Dr. Gorge Varughese presented the recent developments of the Wheat Program. Sustainability is an important objective for the Wheat Program. Other important concerns are increasing yield potential, grain quality, late planting (specially for Asia), and the completion of an International Information System.

Dr. David Hoisington stated that applied biotechnology has become an essential research tool to support breeding activities.

II - UPDATE

An agreement of cooperation between CIMMYT and the CIO was signed on September 15th 1986 in Paris. Existing Programs of mutual interest were officialized and new ones progressively implemented, either through regular exchanges of plant material, visits by researchers or secondments.

CIMMYT and CIO reactivated their Collaborative meeting since 1992 and hope to maintain the timeframe of a meeting every two years nurtured by intermediate informal meetings, if needed.

III - TIMETABLE OF CIMMYT-CIO MEETINGS

MONTPELLIER

MONDAY 30

A.M.

9.00	9.15	Welcoming
9.15	10.15	Presentation CIMMYT
10.15	10.30	Coffee break
10.30	12.00	CIO thematics

10.45 Conservation and Management of Plant Genetic Ressources
11.05 Biotechnologies
11.25 Varietal improvement
11.45 Agronomy and Economics

P.M.

12.00	1.30	Lunch (CIRAD)
1.30	4.00	Maize programs
4.00	4.15	Coffee
4.15	6.30	Wheat and other cereals

TUESDAY 31

A.M.

8.30	10.30	CIRAD Laboratories :
		Molecular Biology
		Phytopathology (viruses)
		Maize transformation
10.30	12.30	ORSTOM Laboratories
		Agropedology/Erosion
		Pest Management
		Genetics

P.M

12.30 2.30	Lunch (ORSTOM), visit to ILTAB/INRA Station Maugio
2.30 5.00	INRA Laboratories Field Trials Wheat Program Physiology stresses, cereals technology
5.00 6.30	Coffee break
5.30 7.00	Synthesis in ENSAM Headquarters
8.00	Dinner offered by CIO

PARIS

WEDNESDAY 1

2.00 P.M.	Meeting with CRAI

IV - WORK METHOD

Since presentations on the two Research Systems [the CGIAR (Consultative Group for International Agricultural Research) System and its international centers, the French agricultural research System], were given during the second Collaborative Planning meeting, it has been decided to have a brief updating presentation from CIMMYT, and presentations of themes of expertise of CIO which could lead to new collaborative projects with CIMMYT.

Four themes were presented :
(Appendix 1)

- "Conservation and management of plant genetic resources in France", by A.Charrier.

The discussion emphasized the advantages of large exchanges and close ties between national and international data bases. Respective positions of CIO and CIMMYT regarding the OAA general agreement on genetics resources were also discussed.

- "Wheat Biotechnologies", by Gérard Doussinault.

INRA will maintain a reserve of genetic diversity, even with no immediate utility. Routine analysis will no longer be done at INRA which will focus on basic research while other activities will be carried out by the private sector.

- "Maïze Varietal improvement" by Jean Leu Marchand and Brigitte Gouesnard.

At CIRAD, Breeding aims at responding to farmers needs with different levels of intensification. The keywords for varietal improvement are Hybrids, Resistance (insect,viruses, cold), and grain quality.

INRA is mostly interested in cold tolerance on maize and, on drought tolerance, resistance to leaf rust and powdery mildew for wheat.

- "Agronomy and maïze sub sector" by Jean Claude Follin.

A considerable amount of work is underway at INRA and CIRAD concerning the study of the inter-relation between cropping techniques-conditions-production.

The objective is to better understand commonly-used cropping systems and to propose new alternatives (cropping tecniques) responding to constraints like water management, soil erosion reduction, fertility....

An important domain of research is the study of the competitiviness of the maize subsector analyzing the productivity of local production. Recent studies in Africa compare alternatives of local production and importing particularly for supplying large coastal cities..

V - PROGRAMS AND WORK PLANS
(1994-1996 and beyond)

Each ongoing program was reviewed before a discussion on new proposals. New commitments are integrated as part of this report in the information sheets describing program objectives, contents, mobilization of staff and financal resources, names of correspondents (organizational contacts). (Appendix II)

V.1 - GENETIC RESOURCES

V.1.1 STUDY OF THE DIVERSITY AND GENETIC RESOURCES OF TRIPSACUM AND THE POTENTIAL TRANSFER OF GENES TO MAIZE (APOMIXIS IN PARTICULAR) (Information sheet N° 1-1)

Project Type: I.

The program was reviewed earlier at CIMMYT by a review team, and a work plan for 1994-1997 was approved.

V.1.2. PROPOSED PROGRAM TO STUDY THE FLOW OF GENES BETWEEN LOCAL MAIZE CULTIVARS AND RELATED SPECIES (TEOSINTE) (Information sheet N° 1-2)

Project type: I.

This project has been fully presented and discussed. Both parts agree on the interest of this research.

A team of two scientists, one from INRA, and one from ORSTOM has been identified to be assigned to CIMMYT. The project will be carried out at CIMMYT as soon as appropriate funding is made available.

Due to the strong interest of France to develop genetics resources activities within the CGIAR centers, it is suggested that the French contribution to CIMMYT be expanded to allow the implementation of this project in 1994.

V.1.3. NETWORK OF GENETIC (RFLP) MARKERS FOR MAIZE AND WHEAT
(Information sheet N° 4-6)

Project type: III

Information was exchanged on various projects in this domain.
Contacts will be maintained especially between INRA and CIMMYT.

V.1.4. "BT" PROJECT - RESISTANCE TO INSECTS
(Information sheet N° 1-4)

Project type: I.

The recent visit of Dr Hoisington to CIRAD was an opportunity to review the project. CIMMYT and CIRAD are fully satisfied with the implementation of this project aiming at producing insect-resistant transgenic maize by introducing genes of *Bacillus thuringiensis* toxins. Activities carried out at CIRAD are funded by CIMMYT.

V.2. - VARIETAL SELECTION AND IMPROVEMENT

MAIZE

CIMMYT presented twenty (20) Project ideas internally discussed to strengthen the CIMMYT Maize Program
(Appendix II). Comments from CIO on these orientations would be welcome.

V.2.1. STUDY OF THE GENETIC VARIABILITY AND PERFORMANCE OF HIGH ALTITUDE TROPICAL MAIZE IN TEMPERATE AND COLD REGIONS
(Information sheet N° 4-7)

Project type: II.

CIMMYT would like to move this project from Type two to type one and would welcome a post-doctoral researcher or a visiting scientist from INRA for two or three years. A proposal will be sent by INRA for consideration by July 1st 1994.

V.2.2 RESISTANCE TO INSECT PESTS IN THE CARRIBEAN BASIN
(Information sheet N° 2-2)

Project type: II.

A visit of C. Welcker to CIMMYT is planned for July 1994 to discuss the orientations and next steps. CIRAD is no longer involved in the direct implementation of this project.

V.2.3. HYBRID MAIZE PROGRAM
(Information sheet N° 2-3)

Project type: III

It has been decided to continue exchanges of information on methodology, given that plant exchanges fall under confidentiality rules of an agreement between CIRAD and a private company.

CIMMYT is interested to receive information from CIRAD on the utilization of CIMMYT germplasm in the CIRAD program in Brazil.

INRA is also involved in information exchanges

V.2.4. VARIETAL IMPROVEMENT OF MAIZE POPULATIONS IN AFRICA

Project type: II

CIMMYT indicated that it has responsability for conducting
research on this topic in Eastern and Southern Africa. IITA has responsibility for Central and Western Africa.
CIRAD cannot involve a breeder in this project, at the present time.

Central and Western Africa.
CIRAD cannot involve a breeder in this project, at the present time.

V.2.5. VIROLOGY PROGRAM.

Project type: I.

V.2.5.1 RESISTANT VARIETIES OF MAIZE IN ZIMBABWE TO TROPICAL VIRUSES
(Information sheet 2-5)

CIMMYT and CIRAD restated their common interest to have joint activities in this domain. CIRAD has extensive expertise in developing maïze streak resistant varieties, and in transfering those characteristics. Recent varieties released in La Réunion island and Togo are performing very well.

CIMMYT has proposed that CIRAD second a phytopathologist to HARARE and pay his or her salary.

Collaboration with CIMMYT can be envisioned as either a CIRAD scientist located in Zimbabwe, or a CIMMYT scientist outposted at CIRAD La Réunion.

Action:
- CIRAD will send to CIMMYT Harare resistant varieties issued from its program in Togo and La Réunion,
- One or two scientists from CIMMYT will visit CIRAD programs and laboratories in La Réunion,
- A research proposal will be considered, then.

CIMMYT will propose, as soon as possible, the name(s) and period(s) suitable for its scientists to visit to La Réunion.

V.2.5.2 MAPPING OG GENES FOR MAIZE VIRUS RESISTANCE

CIRAD and CIMMYT agree on a secondment of a pre-doc, Mrs Alix Pernet, to the biotechnology laboratory in El Batan, for a period of one year, starting october 1994. A Memorandum of Understanding is under consideration by both parties.

V.2.6. ALUMINIC TOXICITY OF SOILS FOR MAIZE CULTIVATION

WHEAT

V.2.7. IDENTIFICATION OF MOLECULAR MARKERS OF DROUGHT TOLERANCE IN CEREALS.
(Information sheet N° 4-3)

Project type: I.

CIMMYT AND INRA expressed a common interest for this Project that could be implemented with an INRA scientist joining the CIMMYT Wheat Program and using the Applied Biotechnology Laboratory facilities.

A request for a position of an Associate- expert (Sylvie Lewcki) was sent to the French Ministry of Foreign Affairs.

V.2.8. RESISTANCE TO LEAF RUST AND POWDERY MILDEW.
(Information sheet N° 4-1)

Project type: I

Dr.M.Van Ginkel (CIMMYT) will visit INRA in June 1994, as a follow up of the visit of Dr.Doussinault (INRA) to CIMMYT last March.

Both Institutions insist on the complementarity of current research carried out by these teams. Collaborative activities on this important scientific topic will be mutually benefitial.

The project will be carried out with a French Doctorate located first in INRA, then in CIMMYT in 1995.

V.2.9. DATABASE MANAGEMENT
(Information sheet N° 4-2)

Project type: II.

CIMMYT proposes to transfer to France the software it developped with funds from USDA, Canada, Australia, Denmark, and hopes that INRA will participate in this Project.

INRA will contact its partners on genetic resources in France to request that they provide financial support to this activity.

V.3. - AGRONOMY

V.3.1. AGRONOMY AND RAIN-FED MAIZE CROPPING SYSTEMS IN THE PACIFIC REGION OF MEXICO IN COLLABORATION WITH INIFAP

(Information sheet N° 3-1)
Project type: I.

This study of the performance of direct tillage techniques using residual mulching, and an anlysis of its economic feasibility for climatic zones subject to drought (analysis of techniques- soil - plants interaction suitable for the plot cultivated), started in September 1993 with E.Scopel mission (identification of experimental sites, equipment purchase) to CIMMYT.

A MOU was signed between CIMMYT an CIRAD in January 1994. CIRAD has signed the second MOU submitted to INIFAP.

E.Scopel is expected to join the CIMMYT Maize Program in June 1994 for a first period of two years. He will collaborate with the NRM Group too, and benefit from partial support from the Economics Program (L.Harrington).

V.4. NATURAL RESOURCES MANAGEMENT.

Project type II.

CIMMYT presented the rationale and objectives of its NRMR Group.

The current projects of this Group were discussed. CIRAD indicated its experience and approaches in research on cropping systems specially in Africa were different studies have been carried out on cotton and maize. A Doctorate thesis valorizing some of these studies will be published soon and made available to CIMMYT.

CIRAD is open to collaborate on the designing of methodology (how to take into account farmers diversity, long term trials) for the CIMMYT Project "Fostering farmer participation in natural resources management research and extension for maize-based systems in hillsides of Mexico and Central America.

ORSTOM is developping in Mexico and Central America programs on the dynamics of production systems and natural resources management for sustainable development. These projects are carried out in collaboration with the Collegio de Postgraduados, Montecillos, CIAT and different NARS. ORSTOM would welcome poposals from CIMMYT to participate in these projects with regional perspectives.

APPENDIX I

CONSERVATION AND MANAGEMENT OF PLANT GENETIC RESOUCES IN FRANCE

France has a long tradition in the conservation and management of Plant Genetic Resources (PGR).

Numerous actions are developed for ex *situ* conservation by different partners from both public and private institutions, all concerned by plant breeding. Non governmental associations are also efficient in this sector.

Concerning *in situ* conservation, a significant effort has been made in the forest sector and is now in progress for grass plants. The conservation of wild species related to domestic plants is also carried out by national botanic gardens and natural parks.

I - Institutions involved in PGR

National coordination in PGR was assumed by the "Bureau des Ressources Génétiques" (BRG) which was created in 1983. The aim of this board was to aware the whole French Community of the problems refering to conservation of plant, animal and microorganism genetic resources as a protection of biological diversity. A Groupement of Scientific Interest (GIS) has been created in 1993, with the partners directly involved in the conservation of genetic resources : 3 ministries, 5 public institutions and GEVES.

The BRG has ensured different actions :

- supporting and incitating research works refering to the management of PGR;

- coordinating several actions of PGR conservation (establishment of networks; organization of actions developed separately by different institutes; ...)

- promotion and dissemination of knowledge in terms of PGR (meetings, publications).

National Institute for Agronomical Research. INRA maintains important collections

of PGR, recovering about 80 cultivated species (100 000 accessions) and 60 forest species (30 000 trees). These collections include populations (local ecotypes as well as artificial populations), old and modern varieties (clones, inbred lines, hybrids and populations), specific genetic material (alloplasmic, isogenic, aneuploid and haploid lines, translocated material, ...) and wild species related to cultivated plants. These collections are properly maintained as long as IRA keeps a breeding program on associated species.

INRA has also been an active partner in the development of a network for *in situ* conservation of forest species in collaboration with CEMAGREF and ONF. *In situ* conservation is also thought for meadow species : *Dactylis glomerata, Festuca, Festuca arundinacea, Lolium perenne* and *Trifolium pratense*.

CIRAD and ORSTOM are concerned with tropical species. They have made numerous prospections of local cultivars and their wild relatives in Africa for the most important food plants : cereals, vegetables and fruit plants, root and tuberous plants. International Centres for Agronomical Research were supplied with this material. More, duplicates of collections are secured in France and stored either in cold rooms (rice, maize, *Sorghum*, millet, *Panicum* Gombo or *in vitro* (pineapple, banana, yam and manioc). French gene banks from CIRAD and ORSTOM include each about 15 000 resources.

Both institutions are also concerned with industrial crops : cotton plant, palm tree, coconut palm, coffe-tree, cacao-tree and several forest species for which large prospections were also carried out. The conservation of these woody species is made in fields including several thousands of trees, and is distributed over the agronomical stations from African and American partner countries. Also, researches for *in vitro* conservation and cryoconservation are made in collaboration with the CNRS for these recalcitrant species which do not accept dessication and storage in cold rooms.

The CNRS and Universities are not directly involved in the conservation of genetic resources. However, they develop numerous research actions which can help in the management of diversity.

The MNHN is concerned with the study of wild plants and the evolution of ecosystems. It keeps up large botanical collections and is in charge of the inventory and the follow-up of the natural patrimony in France.

The national repositories are very efficient in the collection, conservation and test of old fruit and vegetable varieties : there are large collections of *Prunus* species at the repository of Porquerolles, and of *Malus* and *Pyrus* as well as rose trees in the repository of Gap-Charance.

Also the development of in situ conservation in National Parks and Repositories is

highly encouraged by the Ministry of Environment (ex : *Beta, Brassica, Agropyrum, Daucus, Prunus, ...*).

The GIP-GEVES is concerned by ex Situ conservation . It maintains seeds of old and new varieties which are or were registered in the French official Catalogue. These varieties are characterized by international UPOV criteria and are regularly multiplied. Generally, these resources are protected and their distribution is not free.

The GIP-GEVES is also involved in the establishment and the coordination of several networks for genetic resources conservation.

Private breeders maintain specific collections which are not free. Some of them are also involved in French and international networks for genetic resources conservation, in which they accept to introduce a part of their material and to participate in their evaluation.

Many local organizations (NGO) are also active for collection and conservation of genetic resources. Some of their actions were federated by the AFCEV society, which has been particularly efficient in the conservation of fruit trees : definition of standards for the description of varieties, and specifications for the approval of orchards-conservatories; writting of didactic handbooks for description of varieties.

Several research works about biochimical and molecular characterization of the genetic diversity and methodologies for management of genetic diversity are developped on several species by MNHN, INRA, CNRS, ORSTOM and Universities.

The first one concern basic work on :

- molecular biology of plant genomes ;
- reproductive systems and ecology , directly connected to spatio-temporal structutation of genetic diversity ;
- cryoconservation of embryos and meristems ;
- physiology of seed.

The second one refers to the characterization and the organization of diversity based on numerous criteria. The comparison of the results obtained with different criteria will help to better understand how the diversity is structured for characters submitted or not to artificial selection. It will also help to rationalize significant criteria for long term genetic resources management.

The third type of work refers to the creation of core-collection on one hand and of genetic pools on the other hand in order to reduce the number of resources which

must be kept while maintaining most of the original diversity, and to enhance their utilization.

The last studies refer to the dynamic management of genetic variability, which needs a better understanding of genetic entities to be kept, as well as studies for optimization of *in situ* management.

II - An original way for conservation and management of genetic resources : the constitutin of networks.

2.1 General principles

The first steps is to make an inventory of genetic resources available in the country, for a group of species.

The second step is to ensure the multiplication of all resources introduced in the network. The originality of this system is that the labours devoted to characterization and multiplication of all resources are distributed over the partners who have joined the network. The cost of conservation is shared between all partners. Moreover, a double of the collection is always secured in a definite place . This organization needs a coordinator to manage the whole system.

We shall give few examples for active networks

The Cereals network was initiated in 1991 by INRA, GEVES and private breeders (SPSS). It includes about 15 000 accessions of *Triticum aestivum* (about 50%), *Triticum duru, Hordeum bulbosum, Avena sativa, Secale* and Triticale. It is managed by a piloting committee, which includes the coordinator, several representatives from INRA, GEVES and private breeders and one representative of the Ministry of Agriculture and of the Bureau des Ressources Génétiques (BRG). It is coordinated by a person from GEVES, who is working next to INRA plant breeders in Clermont-Ferrand, and who is responsible for the double of the whole collection stored in cold room at Clermont-Ferrand.

Today, the network includes resources which are maintained over 6 INRA plant breeding stations and over 6 private breeders station.

A cooperative program concerning the conservation of maize populations' genetic

program. 1200 populations, which are maintened in cold rooms at 4°C in Montpellier, were characterized for *per se* value and testcross values, and then grouped in 32 genetic pools. The agronomical performance of 24 of these pools was improved, by crossing them with improving hybrids. These pools represent interesting basis for the development of recurrent selection shemes ; they are now managed by the partners of the program. Also, the multiplication of individual populations (every 10 years) is distributed over years and artners, in order to reduce the annual cost of conservation for each member of the network.

France is also involved in actions developed by the International Board for Plant Genetic Resources (IBPGR), particularly devoted to developing countries in connection with CIRAD and ORSTOM : prospections for main cultivated species ; organizzation of their conservation *ex situ ;*
definition of passport data for characterization of resources ; setting of local coordinators to work in a consistent way with natinal programs. France is responsible for several databases at an European (Lucerne, *Prunus)*
or International (Banana, Coconut, Citrus, Cotton ..) level.

VARIETAL IMPROVEMENT

1. MAIZE

Overseas: CIRAD and INRA/Guadeloupe

Research seeks to identify varieties which satisfy the yields sought by farmers in developing countries: up to 20-25 q/ha, essentially using local varieties well-suited to largely-non-intensive farming; from 20 to 50 q/ha, using varieties with higher potentialities; and greater than 50 q/ha, implying intensive farming requiring hybrids.

Obtaining the potentialities corresponding to the first two targets is no longer a research objective for us: local varieties meet the needs described in the first case, while the varieties created by the CIMMYT and the IITA are perfectly adapted to the second case. Our work is thus limited to the development of hybrids for tropical zones.

On the other hand, there is much work to be done to assure that these potentialities may be realised, particularly with respect to resistance or tolerance to various types of biotic and abiotic stress. Research is now being conducted on resistance to viruses and to stalk borers, as well as on tolerance to aluminium toxicity.

Finally, the use of a variety depends on the quality of the grain and its acceptance by users, particularly in the case of human consumption. This is also an area in which the CIRAD is involved through studies on the first - and in certain cases, the second - stage of grain processing and of the variety's aptitude to undergo such processing.

France: INRA

The main lines of research involving maize hybrids concern:

Adaptation to the environment: earliness, tolerance to low temperatures, lodging resistance, insect tolerance;

- Breeding methodology, with exotic variability introgression (source population project conducted in collaboration with the CIMMYT, in particular), optimisation of recurrent selection and creation of lines using elite populations;

- A specific maize silage programme: the interaction between food value and sensitivity to lodging and productivity.

Special importance is currently being placed on reducing input, especially pesticides and nitrogen.

ORSTOM

At present, no research on varietal improvement is being conducted at the ORSTOM.

2. WHEAT

Research on wheat varieties (hard and soft wheat), barley and triticales is presently underway at the INRA.

Relying on the strengths of quantitative genetics, breeding methodology, and breeding methods for achieving parasite resistance and quality, this research involves:

-Reproductive systems and recurrent selection, attaining heterosis, interspecific crossing and interaction between genomes;

-Adaptation to stress conditions (related to drought, cold, mountainous areas, nitrogen), and resistance to disease and parasites, with a special focus on reducing inputs;

-Pasta-making and bread-making quality.

and should thus lead to the creation of plant material of high agronomic value which satisfies users' needs.

Research on cold tolerant material

Since the fifties, maize breeding for Northern Europe conditions has been conducted according to a scheme based on two combining ability groups : European flint (for cold tolerance and good early vigor) and US dent (for gigh yield potential). But genetic variation among flint material is small and selection gain is now limited. Thus, INRA is interested in studying exotic material, especially tropical highland populations which are supposed to be cold tolerant.

Some CIMMYT pools and population (Pool 4, Pool 5, Pop 86) were inroduced in 1985 and 1986 in our recurrent selection programs and give now interesting results for silage production. By the time, CIMMYT introduced elite temperate material in his populations in order to improve inbreeding tolerance, photoperiod insensitivity, resistance to root lodging and to *Ustilago maydis*. In 1990, the first CIMMYT highland inbreds were released and both institutes decided to study five of them in a diallel cross with five temperate inbreds. The parents and 45 hybrids were planted in 1993 in four locations (two locations in Mexico, and two locations in France). We hope to publish very soon the results concerning combining abitities and cold tolerance in a first paper (C. Giauffret, J. Lothrop), and those concerning methodologies to introduce exotic germplasm into adapted material in a second paper (A. Pernet, B. Gousnard, C. Giauffret, J. Lothrop).

In 1995, around 150 CIMMYT lines which could be interesting for Europe will be evaluated (per se, and crossed with two testers) in France. Since CIMMYT recently reduced the highland maize program, they are now very interested in testing their experimental material in cold locations outside Mexico. Based on these results, a further collaboration should be suitable for both institutes. Our main CIMMYT collaborator will be G. Srinivasan.

Research on photoperiod insensitivity

Tropical maize appears to be very photoperiodic, which means that it is diffucult to use it in long-days areas. For CIMMYT, the impact of one of their main population (Tuxpeno) is limited because of its photoperiodism. For INRA, some CIMMYT accessions which could be interesting for Europe never flower in France. Both institutes initiated a collaboration a few years ago. They published two scientific papers together (Bonhomme et al., 1990 , Bonhomme et al., 1994). They would like to continue their collaboration, first to study photoperiod x temperature interactions, and second perhaps to look for molecular markers of photoperiod insensitivity.

AGRONOMY

1-Study of the effects of cropping techniques

A considerable amount of work currently underway at the INRA and the CIRAD concerns **the study of the inter-relation between cropping techniques - conditions - production**. Generally, such work involves completed studies which rely largely on research done in rural areas.

This work first aims to better understand and **diagnose commonly-used cropping systems**. Once this diagnosis has been performed, attention is then focused on **modifying these systems** (or proposing new ones) so as to render them more efficient given the main physical and socio-economic constraints. The consequences of a given technique on the environment are increasingly being considered.

Within this area of activity, several main themes related to cereal production may be identified:

_Water management under heavy rainfall conditions. Several research teams are working to develop cropping schemes which make optimum use of rainwater while reducing risks of moisture stress for various annual crops, including maize (INRA, CIRAD) and wheat (INRA). These studies seek to explain how a technique or set of techniques modify the availability of moisture in the soil and the demands of the plant cover.

_Techniques for managing run-off and reducing soil erosion and other types of physical soil degradation (CIRAD, INRA, ORSTOM).

_Mineral and organic fertility: research into farming-related modifications of the main mineral element cycles (their availability to the crop, medium and long-term effects, soil-contaminating effects).

Work in this area is particularly rich and ranges from the specific (plant physiology) to the general (ecosystem). With regard to nitrogen, the following studies are underway: 1) Research for indicators of absorbable soil nitrogen pools for a maize crop (CIRAD), 2) Analysis and evaluation of maize rhizospheric processes which enhance nitrogen mineralisation of the soil and its use by the crop (CIRAD), 3) Analysis and modelling of the nitrogen cycle in tropical soils (ORSTOM), and of nitrogen fertilisation of maize (INRA, CIRAD), 4) Optimisation of nitrogen fertilisation of maize and managing organic resources with relation to edaphic and climatic conditions (CIRAD).

In addition, studies related to the effects of toxicity of heavy metals - especially nickel - on maize are in progress (ORSTOM).

-Controlling the soil's biological components: effects of farming practices (direct results of control actions or indirect results of the practices themselves) on weed or pest populations (CIRAD, INRA).

2-Applications

The basic knowledge acquired on the functioning of cultivated fields is synthesised in the form of **modelling tools**, used for:
1)Establishing operational decision rules with respect to the management of the field, or even the farm holding itself (INRA);

2)Extrapolating *a posteriori* locally obtained results;
3)Establishing *a priori* high potential and high risk areas concerning agro-pedo-climatic factors for a given crop, such as maize. In West Africa, for example, drought risk areas were identified using not only pluviometric data, but also edaphic characteristics and the possible interaction with cropping techniques (CIRAD).

Points 1) and 2) above rely increasingly on the use of **Geographic Information Systems** whenever necessary information is available in such form.

Finally, there are numerous interfaces with agricultural development in France and in tropical countries. Such work then includes the collaboration of agro-economists. Approaches which take into consideration the systemic aspect of holdings and the agricultural context are preferred. As such, solutions are sought for adapting technical innovations which take into account the main aspects of these systems (material constraints, farmers' goals, the risks related to each alternative, and those which are acceptable to the producer) so that they may be compatible with their functioning and acceptable to farmers (INRA-SAD, CIRAD-SAR).

(1) CIO : Comité Inter Organismes(France), grouping together in this instance, CIRAD, INRA and ORSTOM, and occasionally associated with CNRS and university laboratories.

(2) CIMMYT : Centro internacional de Mejoramiento de Mäiz y Trigo.

ECONOMICS OF THE MAIZE SECTOR

To reply to its own needs and to those of its external partners, the CIRAD has decided to increase its analyses of international markets and of the competitiveness of several sectors in various countries and regions of strategic interest, to compare the performance of products and the economic consequences of the alternatives of local production and importing, and to evaluate the major choices for these sectors: reduction of the cost of input, increase of work productivity, etc. The most likely hypothesis is that these studies will continue in a social and economic context tending to reflect the decline of consumer buying power, accompanied by an increased demand for food products.

Studying food sectors in French-speaking Africa, still the major zone of intervention, is made more difficult by the present shift from self-sufficiency agriculture to market agriculture, extremely sensitive to international markets and the importation policies of the various countries involved; this is especially important for both maize and rice. Any planned activities concerning the maize sector thus imply thorough knowledge of three types of markets:

-The international market, particularly for supplying large coastal cities, where the competitiveness of locally produced maize should improve following the devaluation of the CFA Franc;

-Regional markets, for landlocked cities and areas as well as border zones between Franc area countries and others;

-Local markets, be they traditional or more recently organised for monetarised commerce;

Another aim is the increased understanding of the workings of maize production units.

The most recent work has involved a study of the extension of maize farming in West Africa, the results of which were presented at the CIRAD - UNB - FAO Seminar in January 1994 on the production and development of maize in this region.

APPENDIX II

PROJECT IDEAS TO STRENGHTEN THE CIMMYT MAIZE PROGRAM EFFORTS.

1. Improving standability and reducing economic losses in maize by developing suitable maize germplasm through selection under various stresses and by using stalk strenght measuring techniques.

2. Combining dwarf and leafy genes with important agrnomic traits to develop unique productive maize genotypes.

3. Maximizing manifestation of yield heterosis in tropical maize hybrids through combination of inbred progenitors selected for genetically divergent alleles of some yield contributing traits.

4. Identification, chracterization and measuring magnitude of yield heterosis among inbred lines selected for divergent alleles for several traits.

5. Partitioning yield heterosis and measuring relative contribution of inbred performance and heterosis component in lines selected for different yielding ability.

6. Eliminating introgression barriers between temperate and tropical maize germplasm through development of photoperiod insensitive and multiple foliar disease resistant maize germplasm.

7. Improving tolerance to inbreeding depression and hybrid oriented features of tropical maize germplasm for accelerating hybrid maize development in the third world countries.

8. Identifying physical, chemical and genetic factors contributing to ear rot resistance in maize kernels for reducing economic losses from ear rot damage.

9. Building-up resistance to stalk rot complex in maize through abiotic stress induced techniques and artificial inoculation techniques with appropriate stalk-rot causing organisms.

10. Studying relative importance of pre-flowering, post-flowering and post-physiological maturity traits in developing early maturity high-yielding maize germplasm.

11. Characterization of relationship(s) of the grainfilling period of inbred lines and their hybrid involving tropical maize germplasm.

12. Improving cold tolerance and resistance to inbreeding depression in highland maize germplasm.

13. Combining streak resistance and downy mildew resistance in Lowland Tropical Germplasm adapted to Western Africa.

14. Improving host plant resistance to some major insect pests in the Mid Altitude maizes of Africa.

15. Investigations of the physiology and genetics of flooding tolerance in tropical maize ; development of flooding tolerant source populations.

16. RFLP mapping of photoperiod insensitivity in tropical maize.

17. The role of abscisic acid in drought tolerance, especially as affected by root development.

18. Physiology and genetics of the "stygreen" character in tropical maize, factors affecting foliar senescence rates.

19. Modelling the dynamics of N and water in maize cropping systems, as affected by tillage & mulch management.

20. Development of a set of biologically - and edophically - based measurs of sustainability in tropical cropping systems. (this allows rapid assessment of whether a cropping system is sustainable in the long run, but from short-term measurements).

APPENDIX III

INFORMATION SHEETS

1 - PROJECT

Study of genetic resources and diversity in *Tripsacum* and possibility of gene transfers to maize (Phase I)

Study of *Tripsacum* gene transfers to maize (Phase II)

2 - PARTICIPATING INSTITUTIONS

ORSTOM
CIMMYT

3 - TYPE OF PROJECT : 1

4 - SCIENTISTS IN CHARGE OF PROJECT

ORSTOM : J. BERTHAUD, Y. SAVIDAN (Phase I) ; Y. SAVIDAN (Phase II)
CIMMYT : D. HESS, D. GONZALES DE LEON

5 - DURATION

September, 1989 through end 1994 (Phase I)
1995 - 1997 (Phase II)

6 - PROJECT PRESENTATION

Justification and Objectives

To gain better understanding of plant material (*Tripsacum*) that has been little studied so far, by using all available methods for the study of genetic diversity ; to use these plants to create new source populations of maize with new traits, e.g. apomixis (Phase I). Phase II of the project will concentrate on transfer of apomixis to maize. Apomictic maize could then be introduced in material from current breeding programs or in landraces.

Results (1989 - 1994)

1 - An unique collection of *Tripsacum* is now available. ca.2,500 plants have been collected throughout Mexico, from over 150 populations. All information, on location and plant morphology is available on a database. Most of the 1,000 plants established in CIMMYT's nursery are available (seeds) for germplasm exchange.

2 - Mexico is the center of diversity of *Tripsacum*. Comparison with other collections, using all tools available, show most species and all ploidy levels, from 2x to 6x, can be found within Mexican borders. Many cytotypes have been described for the first time. Triploids, with 2n = 54, are frequent and have been the subject of a special study.

3 - Apomixis produces maternal progenies (clones) at the same time it helps maintaining a tremendous diversity. Detailled studies of some plant populations show many polyploid genotypes can be fixed in one given population and this polymorphism maintained either through presence of sexuality in diploid individuals, or facultativeness in the apomixis of some polyploids, which is particularly active in producing 2n + n hybrids.

4 - Embryological studies show apomixis to result from diplospory (failure of meiosis) and parthenogenesis (failure of fertilization). All diploid accessions are sexual, while all polyploids are apomictic (between progeny analyses and embryological analyses, a total of 48 populations have been tested). The apomixis pathway is described for the first time in most species. A difference in

meiotic vs. diplosporous timings of development is observed suggesting that, like in aposporous grasses, the first event may cause the second. Other similarities are observed between displospory and apospory which also suggest the two phenomena may have a common genetic basis.

5 - Origin and structure of *T.andersonii*. Progress has been made in understanding the origin of the 2n = 64 chromosomes *T.andersonii*, using isozymes, RFLP analysis and in situ hybridization (in collaboration with Nurul I. Faridi).

6 - *Tripsacum* source of resistance against *Striga*. Though most of agronomical evaluation is still to be done, preliminary studies carried out at IITA strongly suggest that some accessions of *T.bravum* might be good sources of resistance against *Striga*. Another study on this line is underway in the UK, also using some of our materials.

7 - Apomixis can be expressed in a diploid-like structure. dihaploid from 2n = 56 chromosomes maize x *Tripsacum* BC1 plants have been obtained, which have a good seed set. They have 2n = 28 chromosomes associating one haploid set of chromosome from maize (10) with one haploid set of chromosomes from *Tripsacum* (18). This is the first time such an apomictic polyhaploid is reported.

8 - Tetraploid sexual *Tripsacum* have been obtained from colchicine treatment of diploid calli. In vitro culture of diploid embryos, and flow-cytometry evaluation of duplicated sectors prior to plant regeneration made the experiment exceptionally efficient. Over 100 tetraploids have been recovered and more are waiting for evaluation. These materials will make possible a genetic analysis of diplospory within *Tripsacum*.

9 - Maize can be crossed with most *Tripsacum* species. Over 1,000 F1 intergenetic hybrids have been raised to full maturity in the field. *T.dactyloides* and *T.zopilotense* are the two species showing the best crossabilities. F1 between maize and apomictic *Tripsacum* accessions segregate for modes of reproduction.

10 - Apomixis transfer reached the BC2 level in 1993. Ca.3,000 BC1 plants have been established to produce over 20,000 seeds after pollination with maize. From the 5,000 progenies tested so far, 148 BC2 plants with 2n = ± 38 (20M + 18Tr) have been obtained. As the same rate is expected, to pass from BC2 to BC3, the BC2 are multiplied in vitro, aiming at the establishment of a 1,000 BC2 plant nursery.

Project Description (Phase II)

Activities of the 3 years 2nd phase of the CIMMYT-ORSTOM *Tripsacum* Project may be divided in four as follows :

1 - Apomixis Control
2 - Apomioxis Mapping
3 - Identification and study of maize x *Tripsacum* addition lines
4 - Apomixis Transfer

1 - Apomixis Control. Progenies produced in September-October 1994 will be analysed during 1995, which will include 4x sexual x 4x apomictic F1s, 4x sexual x 4x sexual F1s and selfed progenies of 4x sexual plants. A second generation will be produced end of 1995 for analysis in 1996, including several types of backcrosses and sibcrosses. By the end of 1996, we should be able to publish the first comprehensive genetic analysis of apomixis in a diplosporous genus.

These studies would be completed by analyses on maize x *Tripsacum* hybrids and hybrid derivatives. Screening for apomixis will be made using clearing, fluorescence techniques and molecular markers.

2 - Apomixis Mapping. Mapping activities will be either directly related with apomixis or made identify the complete series of addition lines, for future transfers of other traits and addition line identification.

Molecular tools will be applied for (a) tagging the apomixis gene(s) and (b) for mapping, with emphasis on the chromosome or chromosome arm involved in apomixis control.

The first operation will be made to obtain a rapid and efficient screening tool for apomixis, working across *Tripsacum* species (to be tested in other apomicts also) and in all maize x *Tripsacum* hybrid derivatives.

The mapping is aiming at identifying homoelogies between maize and *Tripsacum*, allowing to recognize the maize chromosome or chromosome arm which is homeologous to the *Tripsacum* chromosome or chromosome arm carrying the apomixis control - leading to a reasoned choice of B-A translocated maize lines that could be used to force pairing (and recombination) between maize and *Tripsacum* homeologous sectors.

3 - Identification and study of maize x *Tripsacum* addition lines. Though a few such addition lines have already been produced at CIMMYT, they have not been identified as this requires the development of new screening tools based on chromosome-specific markers. These tools will be developed during 1995 and 1996. The different addition lines produced during this period will be studied for alien chromosome transmission and conservation in the gene bank. Collaboration with the maize program staff will be required for an agronomical evaluation under stresses.

4 - Apomixis Transfer. The 1st phase of the project will end in September, 1994, with the production of BC3 plants associating the full set (20) of maize chromosomes with 2 to 6 alien additional chromosomes. Like for the preceding step, these plants will represent only 2-3 percent of the progenies of BC2s, as these are apomictic and male sterile, making the cross can only be performed using them as female. A working schedule can be built as follows :

from 09/94 to 3/95 :	Identification of the apomictic BC3s, using molecular markers, and in vitro multiplication
09/95 :	Production of BC4s, l.e. monosomic ; addition lines, including the apomictic 2n = 21
96 cycle A :	Identification of all addition lines and multiplication ; study chromosome transmission
96 cycle B :	Production of BC5s a. translocation-induced for direct production of an apomictic maize (depending on progeny size and rate of translocation success) b. crossing the apomictic BC4 with B-A translocated lines
97 cycle A :	Production of apomictic maize from B-A translocated lines
97 cycle B :	Multiplication and release of the apomictic maize

7 - RESOURCES

J. BERTHAUD (august, 1994), geneticist, full time
Y. SAVIDAN, geneticist, full time
O. LEBLANC, (december, 1994) scholarship from France for Ph. D., geneticist, full time
D. GRIMANELLI, scholarship from France for Ph. D., geneticist, full time
M. HERNANDEZ, technical assistant, full time
S. BELLON, technical assistant, full time
Temporary workers.

1 - PROJECT

Gene flow and dynamic conservation of maize genetic resources

2 - PARTICIPATING INSTITUTIONS

ORSTOM
CIMMYT

3 - TYPE OF PROJECT : 1

4 - SCIENTISTS IN CHARGE OF PROJECT

ORSTOM : J. BERTHAUD, Tripsacum Project
CIMMYT : S. TABA, Genetic Resources
D. HOISINGTON, Biotechnology

5 - DURATION

5 Years

6 - PROJECT PRESENTATION

Objective

The objective is to determine the gene flows from teosinte (wild maize) to traditional maize varieties and from modern maize varieties to traditional ones in order to understand their importance for the genetic diversity of maize landraces.

Expected products

- Estimation of gene flow from teosinte to maize landraces in Mexico ;
- Estimation of gene flow from modern maize varieties to maize landraces in Mexico ;
- Proposal of an *in situ* a/o dynamic conservation of teosinte populations and maize landraces, based on scientific criteria.

Methods

This project involves activities in :

- on site research
- experimental breeding
- lab analyses including molecular markers

7 - RESOURCES

Participants

J.L. PHAM, ORSTOM
B. GOUESNARD, INRA
Predoc scientist

Collaboration with local institutions

INIFAP, Biotechnology

Requested Budget

Operational cost : 380.000 US $
Salaries of scientific staff are financed by French Institutions

1 - PROJECT

Risk analysis of escape into wild maize of an alien gene after release of transformed maize varieties in Mexico

2 - PARTICIPATING INSTITUTIONS

ORSTOM
CIMMYT

3 - TYPE OF PROJECT : 1

4 - SCIENTISTS IN CHARGE OF PROJECT

ORSTOM : J.BERTHAUD, Tripsacum Project
CIMMYT : D. HOISINGTON, Biotechnology
S. TABA, Genetic Resources

5 - DURATION

5 Years

6 - PROJECT PRESENTATION

Objective

The objective is to determine the gene flow from cultivated maize to teosinte (wild maize) in order to estimate genetic risk for environment when genetically engineered maize varieties are released. Il is to answer to following questions :

- can toesinte plants incorporate maize genes ?
- can maize genes spread among teosinte populations ?

Expected products

Estimation of possible gene flow from cultivated maize to teosinte in Mexico, allowing an estimation of genetic risk related to release of genetically engineered maize cultivars.

Methods

This project involves activities in :

- on site research
- experimental breeding
- lab analyses including molecular markers

7 - RESOURCES

Participants

J.L. PHAM, ORSTOM
B. GOUESNARD, INRA
Predoc scientist

Collaboration with local institutions

INIFAP, Biotechnology

Requested budget

Operational cost : 380.000 US $
Salaries of scientific staff are financed by French Institutions

Information Sheet N° 1-4

1. Project : Development of transgenic maize varieties resistant to stalk borers.

2. Institutions involved:

CIRAD
CIMMYT
CINVESTAV (Mexico)
EMBRAPA (Brazil)

3. Project type: I

4. Project leaders:

CIRAD: R. Frutos (CIRAD-GERDAT)
CIMMYT: D. Hoisington

5. Duration:

CIRAD: Four years (4), with yearly project evaluation

6. Project description:

The project aims at creating transgenic maize varieties resistant to American and African stalk borers through the introduction of *Bacillus thuringiensis* toxin genes. Participants in the project are the CIMMYT, the CINVESTAV (Mexico), the EMBRAPA (Brazil) and the CIRAD, which has only recently joined in (early 1994). The initial sub-contract with CIMMYT was signed in December 1993, then revised in February 1994 with a time schedule ending in December 1994. The project is funded by the PNUD.

According to the terms of reference, CIRAD shall:

1) Produce and purify *Bacillus thuringiensis* toxins for bioassays to be conducted at CIMMYT and at CIRAD

2) Provide natural strains of *Bacillus thuringiensis* to test their efficiency on insects found at the CIRAD and the CIMMYT.

3) Establish proper mass rearing and conduct bioassays on 5 species of

African insect pests, namely: *Sesamia calamistis*, *Eladana saccharina*, *Heliothis armigera*, *Buceola fusca* and *Chilo partelus*

7. Current project status:

Now, several shipments of purified toxins have been made and CIMMYT currently holds all of the toxins found at the CIRAD. Preliminary bioassays have been performed on *Heliothis armigera* and *Sesamia calamistis*. Results were sent to CIMMYT.

A research assistant(technical staff) has been hired on a short-term contract to perform the tasks to be conducted at CIRAD.

CIRAD project leader travelled to CIMMYT in early February 1994 to set up a schedule and determine experiments to be conducted in the course of 1994. Following a request from UNDP, another trip to CIMMYT is planned for late June-early July to attend a meeting with the External Advisory Committee. A financial and scientific report will be presented to CIMMYT in May and a final report will be sent at the end of 1994.

8. Prospects:

Activities will be performed according to the following schedule :

- Determination of CL50s on *H. armigera* and *S. calamistis*.
- Bioassays on the same two species.
- Bioassays on *E. saccharina* and *C. partelus* and natural *B.thuringensis* strains.

  Bioassays on *B. fusca* with purified toxins and natural strains.
- Shipment of natural strains and purified toxins.

The possibility of extending the project in 1995 will be discussed at the end of 1994. This extension would essentially involve molecular aspects with sub-cloning and "synthesis" of genes found to be effective as a result of bioassays conducted in 1994, and insertion of these genes into plant vectors allowing *in planta* expression. Transformation per se will be conducted at CIMMYT, whereas cloning and gene "synthesis" will be undertaken at CIRAD. A research asssitant(technical staff) would then be hired on a short-term contract to work on molecular aspects. Depending on the results obtained with natural

strains, the cloning of toxin genes from one or more of these strains might be considered.

There is high expectations that the collaboration between CIRAD and CIMMYT will lead to exchange of scientists. The prospect of hosting CIMMYT scientists on sabbaticals at CIRAD was discussed in February, and met with much enthusiasm. The project's leaders are strongly in favour of setting up such exchanges.

Dr.Hoisington's visit to CIRAD in 1994 was an opportunity to revise the activities. CIMMYT and CIRAD are fully satisfied with the implementation and the first results of this project.

9. Resources

CIRAD : R.FRUTOS (full time)
L.DRIF (full time)

CIMMYT: Budget: 80,500 US dollars for the first 14 months.

Information Sheet 2.2

1. Project: Improving maize resistance to insects and adaptation to the Caribbean basin.

2. Institutions involved:

INRA
CIMMYT

3. Project type: II

4. Project leaders:

INRA: C. Welcker
CIMMYT:

5. Duration:

1989 - 1996

6. Project description:

Relying on several studies conducted intermittently in Guadeloupe over the last twenty years, the INRA and the CIRAD/CA (formely IRAT) decided in 1989 to develop a joint project on maize resistance to leaf-eating caterpillars (spodoptera and helicoverpa).

In 1990, close links for cooperation were formed with the CIMMYT and two American research centres.

The first phase of the project (1989-1991) led both parties to increase the size of the research team in 1992 to allow the project to take on the required dimension for achieving the following clear and credible regional objective: the extension of varieties adapted to the main biotic constraints (Moths) and to the various pedo-climatic conditions of the Caribbean basin.

The objectives of the second phase (1992-1994) were to:

- Pursue and broaden the research programme on resistance to the main crop pests: the Moths Spodoptera Frugiperda and Helicoverpa Zea;

- Intensify the breeding operations of varieties which are adapted to pedo-climatic conditions of the area and to common farming practices, and which are resistant to biotic (Moths, viruses, leaf diseases) and edaphic (aluminium toxicity) constraints.

Because of internal obligations, the CIRAD was forced to withdraw from the project at the end of 1993, but maintains strong interest in it.

7. Current project status:

The results may be summarised as follows:

- Constitution of a preliminary "portfolio" of genetic resources;

- Inventory and hierarchy of the main constraints to include in a programme of improving varieties over the medium and long term.

1) Resistance to insects:

Controlling mass rearing of Spodoptera Frugiperda (FAW) and artificial infestation using neonates;

Identifying sources of resistance to FAW (Populations and lines) which may be used in breeding; constitution of start-up pools for recurrent selection;

Realising two recurrent selection cycles in Pop G, including a test on S1 performed via network: Guadeloupe, Poza Rica (CIMMYT) and Mississippi (USDA).

2) Adaptability and productivity:

Identifying three base populations of potential interest to the Caribbean region; breeding a range of varieties with high productivity levels for regional extension and use in breeding schemes.

3) **Exchanges - networking - hosting:**

D. Clavel's (CIRAD) mission to the CIMMYT to work with J. Deutsh

and J. Mihm in June 1992. Tightening links between the Caribbean and Central American Regional Maize Programme through regional partners (Cuba and Dominican Republic) and participation in the PCCMCA in 1993.

Preliminary exchanges with S. Taba on managing and describing populations of Caribbean origin; in Guadeloupe, increasing local resources (4 pools and 110 ecotypes) in 1994 and 1995.

8. Prospects:

- The organisation of regional cooperation around these themes should increase with a view to forming a Caribbean core collection and describing the sources of insect resistance.
- CIRAD is no longer directly involved in the direct implementation of this Program.

Within this context, the following activities are planned:

- A mission by C. Welcker to the CIMMYT (July 1994);

- Hosting a post-doctoral researcher in Guadeloupe on a possible common programme.

Information Sheet 2.3

1. Project: Creating maize hybrids

2. Institutions involved:

CIRAD
CIMMYT

3. Project type: III

4. Contacts:

CIRAD: E. Hainzelin
CIMMYT:

5. Duration:

1992 - 1996

6. Project description:

The CIRAD, in association with Rhône-Poulenc, has set up a project in Brazil for creating maize hybrids - for the Brazilian market as well as the tropical market in general - using lines created by the project or introduced by other organisations, including the CIMMYT.

7. Current project status:

Three hybrids, one of which has been marketed, are currently at the stage of seed production in Brazil.

There are approximately ten other promising formulas.

Lines developed at the CIMMYT have been tested in Brazil and also sent to the INRA. Several of these lines have been used in the experimental hybrid formulas.

8. Prospects:

With regard to epidemiology, collaboration with the CIMMYT-Harare should once again be pursued.

With regard to transfer of resistance, the CIRAD proposes to transfer MSV resistance first, followed by MMV resistance, and finally MStpV resistance, to the pools, populations or varieties held by CIMMYT. Details of a joint research program will be worked out after CIRAD send to CIMMYT Harare resistant varieties issued from its program in Togo and La Réunion, and one or two scientist(s) from CIMMYT visited CIRAD-La Réunion.

Finally, with regard to resistance genetics, a thesis examining the location of virus resistance genes was begun in late 1993 at CIRAD by Ms. Alix Pernet. She will be posted at CIMMYT Biotechnology Laboratory for one year starting October 1994 for carrying out RFLP analyses.

Information Sheet 2-5

1. Project: Study and use of maize resistance to tropical viruses.

2. Institutions involved:

CIRAD
CIMMYT
JOHN INNES INSTITUTE, Great-Britain
INERA, Burkina-Faso
IRA, Cameroun

3. Project type: I

4. Contacts:

CIRAD: J.L. Marchand
CIMMYT:

5. Duration: : 1992 - 1996

6. Project description:

For the last several years, the CIRAD has conducted considerable research on the major tropical viruses affecting maize, particularly MSV, MMV and MStpV. Resistance sources have been identified, vectors are being successfully bred, artificial infestation techniques for MSV and MMV have been developed, and transfers of MSV resistance are currently underway.

The feeding habits of Peregrinus maidis, a vector of MMV and MStpV, is now being studied at the CIRAD-La Réunion.

The CIRAD Montpellier facilities have also begun studying the differences in virulence of the MSV isolates through virus sequencing.

All of this work is being conducted in collaboration with an English laboratory and the partners in Burkina Faso and Cameroon in the framework of the CORAF maize network under European STDIII funding.

7. Current project status:

Laboratory experimentations have been underway since January 1993. A meeting of the collaborating institutions took place in March 1994; the report of the meeting is not yet available.

The first year of field testing was performed in 4 countries. The results are currently under examination.

8. Prospects:

- Work is continuing according to schedule.
- Future developments will be discussed during Dr. C.Welcker's (INRA) July mission to CIMMYT.

Information Sheet 2-6

1. **Project:** Maize tolerance to aluminium toxicity.

2. **Institutions involved:**

CIRAD
CIMMYT
INRA (Rennes et Guadeloupe)
Université de Hanovre, Allemagne
Université Autonome de Barcelone, Espagne
IRA, Cameroun
Université de Londrina, Brésil

3. **Project type:** III

4. **Contacts:**

CIRAD: J.L. Marchand
CIMMYT:

5. **Duration:**

CIRAD: 1993 - 1995

6. **Project description:**

Of major interest to several African countries, the project has received funding support from the European Commission (DG XII/STD 3) and involves a group of German, Spanish, French (CIRAD and INRA) and African (Cameroon) institutions. Its objective is to devise a simple laboratory screening technique, which may be implemented in developing countries, for breeding maize varieties tolerant to aluminium toxicity. This implies a better understanding of the dynamics of aluminium in soils and of the physiology of maize sensitivity-tolerance to aluminium.

Additionally, in the framework of the CORAF maize network, tests will be performed to develop a field screening technique and to identify a range of varieties with known tolerance or sensitivity levels.

Although promising contacts were made with CIMMYT in Harare, nothing concrete has yet resulted.

There are three disciplinary fields in which increased contact with the CIMMYT may develop:

1. Epidemiology and viral diagnosis

CIMMYT in Harare is very interested in the diagnosis kit developed by CIRAD in Montpellier.

2. Transfer of resistance

In addition to the transfer programme activities undertaken by CIRAD with NARs under the CORAF maize network, collaborative projects with CIMMYT may be envisioned. This collaboration would consist in the transfer of resistance held by the CIRAD-Réunion to the advanced varieties of the CIMMYT (Pop. 22, 28, 30, 31, 43, 49).

3. Genetics of resistance

There is a potential for benefitial cooperation in this area between the CIRAD and the CIMMYT through joint use of RFLP techniques.

7. Current project status:

Initial propagation tests are currently carried out at CIRAD-La Réunion for the five first MSV-resistant varieties (including one variety from Population 31, and one from Pool 16 of CIMMYT). The resistance obtained has proven to be greater than that obtained by other institutions (IITA, CIMMYT-Harare, South Africa). Transfers to other varieties are continuing.

Screening procedures for MMV resistance are now operational. The first varieties made resistant to MSV will be screened for resistance.

The CIMMYT-Harare has been provided with a diagnosis kit.

A thesis treating the genetics of MSV resistance is near completion at the CIRAD-Réunion.

8. Prospects:

- Work is continuing according to schedule in the CIRAD program in Brazil.

- Given that plant exchanges fall under confidentiality rules of a previous agreement between CIRAD and Rhône Poulenc, information will be given to CIMMYT on the utilization of CIMMYT germplasm in the program in Brazil, and only on the methodology utilized for hybrid creation.

Information Sheet 3-1

1. **Project:** Study of sustainable productive cropping systems based on conservation tillage for rainfed maize in Mexico

2. **Institutions involved:**

CIRAD
CIMMYT
INIFAP

3. **Project type:** I

4. **Project leaders:**

CIRAD:	E. Scopel (assigned to CIMMYT in May 1994)
CIMMYT :	G. EDMEADES
INIFAP :	D. GONZALEZ and R. ABELDANO

5. **Duration:**

Started-up in 1993 with E.Scopel field mission in Mexico; 4 years, with yearly project evaluation

6. **Project description:**

The project initially resulted from the thesis work of E. Scopel and preparatory missions of CIRAD water management specialists (F.Forest and F.N. Reyniers). Its final version was elaborated following the visit of G. Edmeades to France (May 1992) and of E. Scopel to Mexico (September 1992).

The goal of the project is to:

- Better understand the interactions between technique used and soil conditions, and their consequences on plant behaviour in the case of conservation tillage under the diverse conditions of rainfed maize production in Mexico.

- Study the ways of getting farmers to adopt this technology and identify potential barriers to its extension.

Three types of activity are planned:

- **Basic research** on dynamic aspects of water balance and mineral balance and on their interactions according to the degree of protection offered by the residues. This phase will be concentrated in the region of Ciudad Guzmán, in the State of Jalisco, and will be conducted in collaboration with the INIFAP and the CIMMYT;

- **Scientific and periodic support** for an INIFAP network involving conservation tillage in an area covering approximately twenty villages located in ten Mexican states.

- **A study on the technical and socio-economic characteristics** likely to play a role in farmers' adoption of this technology, to be conducted in collaboration with the Economics programme of the CIMMYT, the INIFAP and possibly the FIRA (development credit and support organisation).

7. Current project status:

Project activities officially began in mid-1993.
Because the CIRAD researcher could not be assigned at that time, a three-months mission was undertaken from July to September 1993, and served to:

- Finalize the respective participation of the different parties involved and corresponding protocols of agreement;

- Prepare the detailed research activities in the area of Ciudad Guzmán in Jalisco (choice and description of sites, designation of the INIFAP researcher working with the CIRAD researcher, location and partial outfitting of facilities);

- Organize an initial workshop which served as a contact base for the different INIFAP researchers working on the test network, and gave the opportyunity of a preliminary evaluation of the network's activities;

- Establish the list of necessary scientific equipments and purchase orders for most of these eaquipments under the 1993 budget.

8 - Prospects :

E. Scopel will be assigned to the CIMMYT in June 1994 for fully benefitting the rainy season and initiate the remainder of planned activities.

9 - Resources : cf. CIRAD-CA/CIMMYT January 1994 Memorandum of Agreement

CIRAD: - a system agronomist, Dr.Eric. SCOPEL, full time,
- Budget : French contribution (through the French Embassy i n Mexico and direct to CIRAD).

CIMMYT:
- Part-time scientist(s)
- Office, Laboratory equipment, computer, operational expenditures
- French allocation to CIMMYT core budget

Information sheet n°4-1

1. Project :
Development of bread wheat germplasm with resistance to leaf rust and powdery mildew.

2. Participating institutions :
CIMMYT
INRA

3. Type of the project : 1

4. Scientists in charge of the project :
CIMMYT : M. VAN GINKEL, S. RAJARAM
INRA : G. DOUSSINAULT

5. Duration : 5 years

6. Project presentation :

INRA and the CIMMYT Bread Wheat Program have a common interest in developing germplasm with durable resistance to diseases in Wheat, and to study the genetics of the resistance (components) involved.
For INRA the main diseases of common interest are leaf rust and powdery mildew. In regard to leaf rust the sources of resistance in France are limited, while knowledge on the resistance to powdery mildew is good.
For CIMMYT the knowledge base and the sources of resistance for powdery mildew are very limited. For leaf rust several genes conferring "durable " resistance at CIMMYT are available, and their genetics is to some extend known.
CIMMYT has access to a large diversity of germplasm from all wheat growing areas around the world, and in addition both institutes develop their own germplasm.
The project will be based on the following axes :

- identification of durable resistance
- genetics of durable resistance
- introgression of durable resistance into superior high-yielding stocks
- molecular and other markers for durable resistance.

7. Resources :
The project activities would be carried out by a post-doc, and would cover a period of five years, half to be spend at INRA in France and half in the CIMMYT Bread Wheat Program in Mexico.

Information sheet n°4-2

1. Project :
Database management for an effective network.

2. Participating institutions :
INRA, GEVES, BRG
CIMMYT

3. Type of the project : 1

4. Scientists in charge of the project:
CIMMYT : B. SKOVMAND, P. FOX
INRA : A. LEBLANC, Y. DATTEE, M. LEFORT

5. Project presentation :
Up to now, information obtained on a genotype could not be integrated to the genealogy of correspondant genotypes. A software has been adapted, so as to get a unique caracterization by genotype, based on its genealogy and identification characters.

The objective of the project is to transfer this software to France and link both database systems of France and CIMMYT.

6. Perspectives and resources :
A detailed project has to be set up by CIMMYT, INRA, GEVES and BRG.

Information sheet n°4-3

1. Project :
Identification of molecular markers of drought tolerance in cereals (bread wheat and barley).

2 . Participating institutions :
INRA - ENSAM
CIMMYT

3. Type of the project : 1

4. Duration : 2 years

5. Project presentation :
Osmotic adjustment can be considered as a major mechanism of drought tolerance in cereals. Variability of this trait and its relationship with yield stability have been studied both in CIMMYT (E. ACEVEDO, S. LEWICKI) and in INRA -ENSAM (P. MONNEVEUX, S. LEWICKI, W. KABBAJ, G. ARNAU, B. TEULAT).
In both institutions, molecular markers have been yet developped among genetic resources to study variations in relation to desirable traits (D. HOISINGTON, D. GONZALEZ DE LEON, D. THIS, F. MOQUET, B. TEULAT, M. ZAHARIEVA).

Cooperation between CIMMYT and INRA - ENSAM will be first used to find molecular markers linked to some drought tolerance parameters (including osmotic adjustment capacity). For this purpose it will be looked for QTL (quantitative trait loci) involved in quantitative parameters variations related to drought tolerance and for molecular markers genetically linked to qualitative characters.
Diploid species (barley, diploid Triticum species) will be first used as models ; variations are being investigated in this material for osmotic adjustment and other drought tolerance related traits. Segregating populations will be developped and several crosses will be mapped and characterized regarding to different traits related to osmotic adjustment . Genetic linkage will be searched using computer programs between physiological parameters and molecular markers. At the same time, candidate genes involved in drought tolerance will be localized on the same crosses to precise the nature of chromosome variation involved in tolerance variation.
INRA - ENSAM is taking in charge barley crosses while CIMMYT will take in charge diploid wheats.
Molecular probes will be exchanged and the same physiological traits wil be analysed in CIMMYT and in INRA - ENSAM.

6. Resources :
Contact will be taken with the French Ministry pf Foreign Affairs to request the 2 years financing of an associate - expert position for S. LEWICKI at CIMMYT.

1. Project :
Valorization of research done on Triticale.

2. Participating institutions :
INRA
CIMMYT
French private breeding companies.

3. Type of project : 1

4. Scientists in charge of the project :
INRA : L. JESTIN, M. BERNARD
CIMMYT : W. PFEIFFEL

5. Project presentation

Triticale has a potential high yield and a remarkable resistance to several constraints, but its use is not as developped as it should be.

the ogbjective of the project is to build a club of French private breeders , associated to INRA and CIMMYT so as to utilize the complementarity of the genetic resources of the different partners to diversify Triticale uses.

6. Perspectives and resources.

A detailed project has still to be set up by the different partners.

Type 2 or 3 projects. Contacts

- Molecular Wheat Genetic Mapping

Contacts between INRA and CIMMYT have already been developped on genetic mapping synthetic wheat x Opata, and germplasm has been exchanged.

A small project could be set up by P. LEROY and M. BERNARD to strengthen these exchanges.

- Resistance to Barley Yellow Dwarf Virus.

The teams of L. BERTSCHINGER (CIMMYT) and J. JAHIER and M. TROTTET (INRA) are working on the same material . Information exchanges on the possibility of transfer, genetic analysis and efficiency would be interesting.

- Septoria Tritici

Teams of INRA and CIMMYT working on Septoria Tritici should develop further contacts.